EFFECTIVENESS OF CONSTRUCTIVIST APPROACH BASED INSTRUCTIONAL MATERIAL ON REACTION, ACHIEVEMENT AND RETENTION OF SECONDARY LEVEL STUDENTS

A
REVISED SYNOPSIS

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1.0.0 INTRODUCTION

Science is a dynamic, expanding body of knowledge, covering ever-new domains of experience. In a progressive forward-looking society, science can play a truly liberating role, helping people escape from the vicious cycle of poverty, ignorance and superstition (National Curriculum Framework, 2005). In other words, society directly or indirectly depends on products and services that are developed with the help of science and technology. Innovations in Science and Technology have changed the way we live, move, communicate, work and play. Meanwhile, news headlines on global warming, environmental protection, cloning or genetically engineered food all deal with science-based issues that directly affect our lives (International Council for Science (ICSU), Paris (2011). In the present scenario, people are faced with a rapidly changing world. To cope up with emerging challenges and for bringing up the standards of living, education of science and technology has become a matter of great concern internationally. Scientific and technological literacy for all citizens is a stated goal of most modern nations; the production of more and better scientists and technologists is seen as a way of competing in the economic arena and as primary means of human condition. One of the biggest tasks facing those addressing the challenge of sustainable development, both in developed and developing countries, is the need to generate the capacity to apply science and technology to this goal (ICSU, 2002). There is no doubt that effective science education can serve as a mean for solving existing as well as upcoming global problems. These different imperatives have to be kept in mind in shaping science education in order to be meaningful in school.

If Science and technological education in schools is to be improved and more students are need to be attracted to careers in science technology, changes need to be made at school and college programmes and in particular teacher education programme. To promote scientific education in the prospective society, science teaching, through multifaceted activities should make students discover and rediscover by reconciling experimental and pupil centered learning. Teaching and learning of science should be aimed at bringing holistic and maximum development of students. According to official policy documents students should have opportunities to develop

comprehensive scientific literacy (National Research Council, 1996). Learning science involves three domains ie. (i) 'Science'. It includes the products of science and technology such as various laws, rules, principles and theories. (ii) 'About science'. Here the nature of practices and products of science and technology and their relationship with societies and environments is included. (iii) 'To do science'. The domain includes expertise, confidence and motivation that are required to communicate knowledge (Hodson, 1998). Such comprehensive literacy is likely essential for citizenship in a democracy (Wellington, 2001). Despite official curricular support for promoting such comprehensive scientific literacy, the school system including administrators, teachers, text book publishers and others often emphasize teaching and learning of 'science' at the expense of learning in the other two domains (Claxton, 1991). But at present, it seems to be very difficult to achieve comprehensive scientific literacy because most of the educational system in the undeveloped and developing countries is still following the conventional lecture method of teaching in which the teacher dominates the entire classroom activity. In such an approach the interaction is basically a one way streak from teacher to students (Gillies & Khan, 2008). There is only minimum student - teacher interaction (Saye & Brush, 2006). The whole class is treated as a single group in which teacher is the authority. Only duty of the student is to record the knowledge coming from the teacher and reproduce it whenever needed. There is no provision for freedom, interaction and social development. Competition is the base value. Students are competing with each other to get a high position in the rank order, only a few who survive these situations are considered as the best and others are treated as worst. In such a class room student's social, emotional and psychological developments are also neglected. Furthermore, conventional education view focused on "instructional goals such as recalling facts, generalization, defining concepts and performing procedures" (Almala, 2005 as cited in Kelly's study). Therefore, this view ignores the difference of pre-existing knowledge of individual and active learning.

Along with this, in conventional classrooms teachers face a number of challenges in learning how to teach science effectively (Brookfield & Preskill, 1999). Encouraging more opportunities for students to learn 'about science' and to 'do science' regardless of their many benefits, has

not been easy. The major problem in science teaching is the teacher's dilemma or the problem of reconciling experimental, pupil centered learning with the requirement that pupils discover and rediscover what they supposed to. Another persistent challenge to science education is student detachment towards science. They view science as too difficult and not relevant to their lives (Kruckeberg, 2006). Thus, it is critical that instruction in science classrooms must engage learners by developing their curiosity and providing opportunities for success. Despite of this students entering the science classroom have a number of previous experiences, ideas, beliefs and expectations about the natural world. The content taught in the classroom is interpreted in the light of this previous knowledge (Howe & Jones, 1998). Even after imparting instructions, student's spontaneous conceptions regarding science often remain at variance with accepted scientific ideas (Yoon, 2009).

This requires teachers to develop a repertoire of instructional techniques, strategies and approaches that can foster productive learning communities as well as professional visions and dispositions effectively (Hofstein et al, 2005). They need to learn how to address problems of practice such as engaging students in science, organizing instruction and developing productive learning communities and in doing so they need to develop their knowledge, teaching practices and dispositions (Copeland, 2002). Despite of these, teachers need to engage students in interesting and real world science information and teach science in an exciting manner (Bagchi, 1997). This demands a paradigm shift in education system from knowledge transmission to knowledge construction. In this context Constructivist Approach viewed as a suitable pedagogy for today's classroom setting. Existing trend of imparting instruction should be changed and the Constructivist Approach should be followed which is moral and more focus on innovative activities and knowledge acquisition.

Constructivism is the last decade's dominant theory that has roots in philosophy, psychology and cybernetics and attempts to describe how people know the world (von Glasersfeld, 1989). Von Glasersfeld (1989) attributes the first constructivist theory to an Italian philosopher, Giambattista Vico, in the early 18th century. Learning theories from Jean Piaget, Jerome

Bruner, Lev Vygotsky and John Dewey also serve as a basis for constructivist learning theory. Several authors need to be mentioned because constructivist theory is a broad approach towards learning. There are three main philosophical frameworks under which learning theories fall behaviorism, cognitivism, and constructivism. Behaviorism focuses on objectively observable aspects of learning. Cognitive theories look beyond behaviour to explain brain-based learning. Learning can also be understood from a constructivist perspective, in which learning is a process of understanding, which leads to modifications in the behavior of the learner due to experiences, a process of individually self organizing knowledge.

According to the constructivist theory, knowledge is being actively constructed by the learner and knowing is an adaptive process, which organises the learners's experiential world (Mayer, 1992; Hendry, 1996). Hence, the learner is not considered as a controlled respondent to stimuli as in the behaviourist rubric (Jonassen, 1990; Perkins, 1991) but as "already a scientist" (Solomon, 1994) who actively constructs knowing while striving to make sense of the world on the basis of personal filters: experiences, goals, curiosities and beliefs (Cole, 1992). Knowledge for constructivism cannot be imposed or transferred intact from the mind of one knower to the mind of another. Therefore, learning and teaching cannot be synonymous: we can teach, even well, without having students learn. Correspondingly, learners do not just take in and store up given information, but they make and test tentative interpretations of new experiences until a satisfactory structure emerges (Perkins, 1991). Therefore, they build a personal view of reality by trying to find order in the chaos of signals that impinge on their senses. Constructivism activates the learner's inborn curiosity about the real world to observe how things work. It is centered on the belief that cognition is the result of "mental construction". Hence, it provides academic freedom to them. They use their own learning strategies by adapting different approaches of constructivism. In the most general sense, it usually means encouraging learners to use active techniques (experiments, real-world problem solving) to create more knowledge and then to reflect on and talk about what they are doing and how their understanding is changing. The teacher makes sure that he understands the learners' pre-existing conceptions, and guides the activity to address them and then build on them. Constructivism modifies role of

teacher that he facilitate and help them to construct knowledge rather than to reproduce a series of facts.

In contrast to traditional approach, the centre of instruction is the learner in Constructivist Approach. Meaningful understanding in this approach occurs when students themselves develop effective ways to resolve problematic situations. Such situations foster motivation, because students have an opportunity to experience the pleasure and satisfaction inherent in problem solving. Constructivists recommend that designers provide problems which may be solved in different ways and leave students struggle with problems of their own choice (Von Glasersfeld, 1993). Such problems are regarded by learners as obstacles in their progress towards a goal. The learner acts as an information constructor. They construct knowledge based on their personal experiences and hypotheses of the environment. Learners actively construct or create their own subjective or objective reality. Learners, through social negotiation, continuously test their hypotheses and create new knowledge, correct previous knowledge, or confirm present knowledge. They linked new knowledge to prior knowledge. Constructivists argued that learner is not a blank slate (tabula rasa) but brings past experiences and cultural factors to a construct new knowledge in given situation. Therefore each learner interprets and constructs the knowledge process differently based on mental representations.

Constructivism instructional methodologies can overcome several weaknesses present in the traditional science classroom. These classrooms often looks like a one-person show with a largely uninvolved learner and are usually dominated by direct and unilateral instruction. Traditional approach followers assume that there is a fixed body of knowledge that the student must come to know. Students are expected to blindly accept the information they are given without questioning the instructor (Stofflett, 1998). The teacher seeks to transfer thoughts and meanings to the passive student leaving little room for student-initiated questions, independent thought or interaction between students (Verginia Assosiation of Science Teachers (VAST), 1998). Even in activities based science concepts, although activities are done in a group but do not encourage discussion or exploration of the concepts involved. This tends to overlook the critical thinking and unifying concepts essential to true science literacy and appreciation (Yore,

2001). This teacher-centered method of teaching also assumes that all students have the same level of background knowledge in the subject matter and are able to absorb the material at the same pace (Lord, 1999). In contrast, constructivist or student-centered learning poses a question to the students, who then work together in small groups to discover one or more solutions (Yager, 1991). Students play an active role in carrying out experiments and reaching their own conclusions. Teachers assist the students in developing new insights and connecting them with previous knowledge, but leave the discovery and discussion to the student groups (VAST, 1998). Questions are posed to the class and student teams work together to discuss and reach agreement on their answers, which are then shared with the entire class. Students are able to develop their own understanding of the subject matter based on previous knowledge, and can correct any misconceptions they have. Both teaching styles can lead to successful learning but it has been shown that students in the constructivist environmental demonstrated more enthusiasm and interest in the subject matter. In fact, repeated research has found that teacher-centered lessons can be less or non-productive, and in some cases, detrimental to the students' learning process (Zoller, 2000). The constructivist teacher help the students through problem-solving and inquiry-based learning activities and others with which students formulate and test their ideas, draw conclusions and inferences, and pool and convey their knowledge in a collaborative learning environment.

Thus, Constructivism transforms the student from a passive recipient of information to an active participant in the learning process. The task of the instructor is to translate information to be learned into a format appropriate to the student's current state of understanding. Always guided by the instructor, students construct their knowledge actively rather than just mechanically ingesting knowledge from the teacher or the textbook.

1.1.0 BASIC ASSUMPTION FOR INCORPORATING CONSTRUCTIVIST APPROACH

There are some basic assumptions for incorporating Constructivist Approach (Merill, 1991 & Smorgansbord, 1997) which are as follows:

1. Knowledge is constructed from experience.
2. Learning is a personal interpretation of the world.
3. Learning is as active process in which meaning is developed on the bases of experience.
4. Conceptual growth comes from the recognition of meaning, the sharing of multiple perspectives and the changing of our internal representations through collaborative learning.
5. Learning should be situated in realistic settings; testing should be integrated with the task and not a separate activity.

1.2.0 CONSTRUCTIVIST APPROACH AND SCIENCE EDUCATION

Constructivism is one of theory of learning which well developed in the recent year and becomes most significant and dominant perspective in science education (Taber, 2006). One of the main aims of science education is to make a meaningful understanding of science concepts. Constructivist Approach seems to be effective in providing meaningful learning. According to this approach, this kind of learning can take place only when the learner relates the new information to his already existing knowledge. The constructivism provides a perspective on teaching and learning science in classrooms, with a view to improving the effectiveness of science teaching in enhancing students' learning. Science teachers can made their teaching more effective by implementing several approaches of constructivism (Activity based learning, problem based learning, collaborative learning, cooperative learning, inquiry learning, group discussions, field visit etc.) in science classroom. Science teachers can use these various approaches of constructivism according to the science topic to be delivered in the classroom.

Along with this in order to make science teaching more effective the extent of prior knowledge about the topic necessary for learning new knowledge should be considered. Furthermore, the subject that will be taught should not be too complex. However, this simplification should be done carefully since it may cause students to develop wrong conceptions. Briefly, the topics of

science and the extent to which students comprehend this knowledge should be correlated. Generally, students' wrong ideas about a particular topic are called as misconceptions which prevent learning and very resistant to change. In science, students hold several misconceptions in many areas. Conceptual change can be accomplished if students are given opportunity to be aware of their ideas, to encounter ideas other than their own and to realize the deficiency in their reasoning. This can be promoted by group discussions which allow students to construct their own knowledge out of exchanges with their friends and the teacher.

In short, according to constructivism the most important thing in science teaching and learning is providing students with learning environment that promotes their understanding of science by co-constructing and negotiating ideas through meaningful peer and teacher interactions. (Solomon, 1987).

1.3.0 ROLE OF TEACHER IN CONSTRUCTIVIST CLASSROOM

In many teaching studies teachers were centrally involved in developing and implementing the teaching approach. It is therefore possible that improvements in student learning arise as much from changes in the way teachers conceptualize teaching and learning and deal with classroom interactions, as the sequence of activities in the teaching. In constructivists' view teachers in science classrooms as authority figures play two essential roles. One is to introduce new ideas or cultural tools where necessary and to provide the support and guidance for students to make sense of these for themselves. The other is to listen and diagnose the ways in which the instructional activities are being interpreted to inform further action. (Driver et al, 1994)

Teachers are knowledgeable experts in their disciplines who introduce the scientific community's culture to students. They provide appropriate experimental evidence and make the cultural tools and conventions of the science community available to students. Teachers use specialized terms and concepts; they show specialized procedure and skills. Teachers are making and providing students with learning environments in which students construct their knowledge by using formal scientific discourses.

According to Perkins (1993), teacher is like a coach in a sense that teacher helps learners to figure out their weaknesses, and work on them, and gives appropriate feedback to help them perform better. To help students adopt scientific ways of thinking and knowing, science teachers should provide various experiences and encourage deep reflection. Student's meanings are listened to and respectfully questioned. Furthermore, teachers should offer helpful interventions to promote thought and reflection on the part of the learner with requests for argument and evidence in support of assertions. (Duckworth, 1987)

Furthermore, teacher can provoke and initiate quality comments in the difficult discussion. The essential role of the teacher is controlling the 'flow of discourse' (Mortimer & Scott, 2000) in the classroom. The ability to guide the classroom discourse as ideas are explored and explanations are introduced, is central to the science teacher's skill and is critical in influencing students' learning. Teachers guide classroom discourses with different kinds of pedagogical intervention. At different times the teacher might play diverse roles which are shown in the diagram as follows:

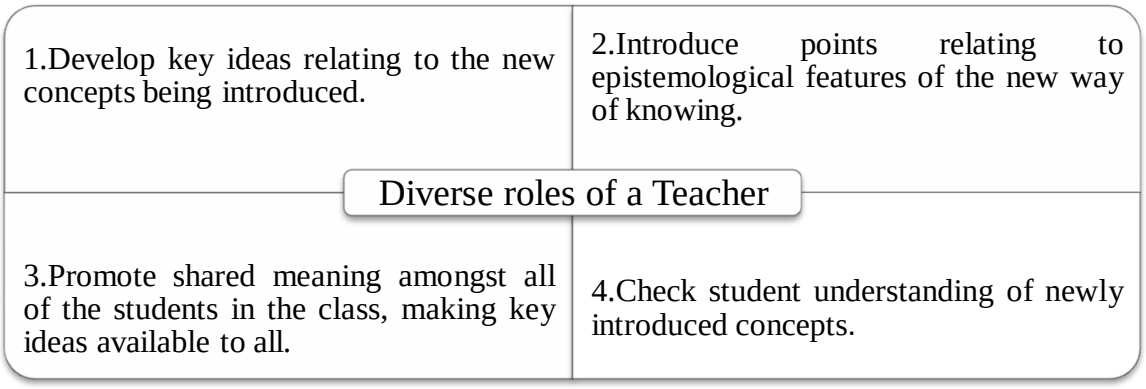

1.Develop key ideas relating to the new concepts being introduced.
2.Introduce points relating to epistemological features of the new way of knowing.
Diverse roles of a Teacher
3.Promote shared meaning amongst all of the students in the class, making key ideas available to all.
4.Check student understanding of newly introduced concepts.

Fig. 1.1: Diverse roles of a teacher in a Constructivist classroom.

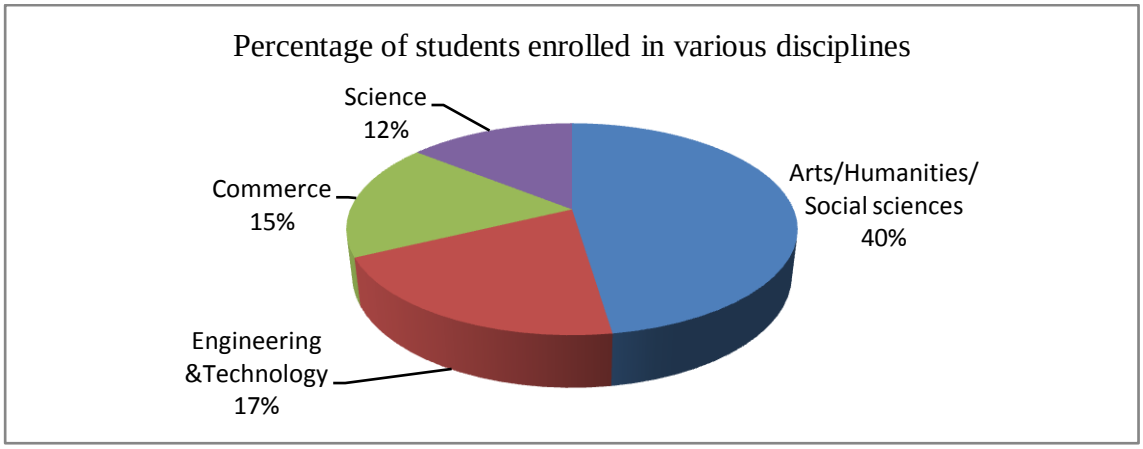
Science teachers play crucial roles in science learning of students not only by making scientific culture tools available to students, but also by guiding and constructing the knowledge with their students through discourse about shared practices. Through dialogical interaction expert teachers can provide support or scaffolding for students' learning as they construct new meanings for themselves.

Constructivism really has changed science education to a great extent. It shows science educators how people learn science. Thus it can be concluded that constructivist class room environment has emerged as a very powerful model for explaining how knowledge is produced in the world as well as how students learn. Constructivism is presently the dominant way of thinking about learning. So this change from traditional approach to Constructivist Approach will help to overcome the traditional obstacles of the educational system.

2.0.0 EMERGENCE AND JUSTIFICATION

The level of scientific attainment of any nation is an important index for measuring its level of development. Opara as quoted by Ajewole (2006) opined every nation craves for science and technological advancement which can be achieved through the medium of education. In modern era, science education is the key component of curriculum (NCF, 2005). Man's enquiry of his environments lead to the study of science and other scientific related studies that provides answers to all questions, lead to wonderful discoveries and inventions that make life easier and gives us a better understanding about our existence. Being an influential subsystem of society science education needs to change its role from preparing a better individual to group of individuals who can work together to solve emerging and future problems. Without science education it will really difficult for us to adapt all changes because science education makes us aware of the latest technologies and all the changes that are taking place in the world.

In science education an enduring problem is that relatively few students are interested in pursuing careers in scientific disciplines, although there are large variations between countries (Schreiner & Sjøberg, 2005, 2007). In some countries, a large drop in the number of upper secondary graduates with a scientific orientation has been observed (OECD, 2008; Shukla et al. 2005). All India Survey of higher education (2011-12) reported that at undergraduate level highest number (40%) of students were enrolled in Art/Humanities/Social sciences courses followed by Engineering and Technology (17%), Commerce (15%) and Sciences (12%).



Graph 1.1: Percentage of students enrolled in various disciplines (All India Survey of Higher Education, 2011-2012)

Previous studies have revealed, however, that while relatively negative feelings of students are usually associated with more traditional approaches to science instruction (Lord, 1997; Shepardson and Pizzini, 1993).

Given these results and the needs of society, there is an urgent need to improve the preparation of the scientists of tomorrow, not only through widespread access to quality instruction, facilities, and research opportunities for all students, but also to improve the motivation and interest of students so that the best of them move toward scientific careers. Teachers can play a significant role in inspiring and directing students as upcoming scientists by using innovative teaching practices for effective learning. Besides this, present system of education pays much focus on teaching instead of learning. Knowledge is presented as primordial and no more relevant to new age requirement. Traditional method is also widely used for teaching science in contemporary Indian science classroom that only transact knowledge from the head of teacher to the head of students. Here science is considered only as a body of knowledge and product end is given more importance than the process aspect of science (NCF 2005). It ignores the mental level and interest of the students. Traditional method of instruction encourages the students to memorize knowledge generally in the form of laws, formulae and theories and students used to reproduce it as such during the examination. This memorization is mistaken for learning, most of what is remembered is remembered only for a short time, but then is quickly forgotten. Thus,

it reduces scope for insightful learning and development of skills like problem solving, creative and reflective thinking. Researches also indicated that teacher centred traditional approach fail to encourage students to think, share ideas and hypotheses and this cause the lower learning achievement (Acar & Tarhan 2007 and 2008).These conventional practices of teaching and learning in science not only have adverse affect on students interest but they also affect their achievement as well as retention capacity.

The weakness of traditional classroom settings can be overcome by the Constructivist Approach of teaching which is an emerging pedagogy among the teaching community across the world and National Curriculum Framework (NCF 2005) confirmed the direction to it in Indian classroom situation. Therefore, there is urgent need to reform our teaching practices in light of recommendations of NCF-2005. In this framework child is viewed as "discover", who actively construct his knowledge and build his understanding by meaning making process. Hence, the framework advocates the use of constructivism at every stages of science teaching.

Till date several endeavours have been made by researchers to study the effect of constructivism on various variables in different disciplines and parts of the world. These researches evident that constructivism encourages learner to reflect and question their own understanding via active meaning making process. Some of the recent researches carried out in this field includes: Kwan and Wong (2015) concluded that both cognitive strategies as well as goal orientations fully mediated the relationships between the constructivist learning environment and critical thinking ability. Choghani (2015) observed a significant difference between average scores of educational performance and its components including test of learning speed, learning accuracy, learning stability and school achievement for students with educational planning and students with educational planning based who are not thought based on constructivism. Duyilemi and Bolajoko, (2014) claims that there were significant effects of Constructivists' Learning Strategies on senior secondary biology students' achievement and retention in experimental group. Ilyas et. al., (2014) revealed that teaching of fractions through Constructivism approach yielded extremely positive and significant learning. Vasan & Gafoor (2014) affirms that there

was a significantly positive effect of constructivist class room environment on achievement of primary students in mathematics. Ramon et.al., (2013) asserts that constructivist model based pedagogy was more effective in improving classroom practices of pre-service teachers. Sridevi (2013) made an attempt to know the reactions of VIII class students towards Constructivist Approach adopted in science teaching and it was found that Constructivist environment was preferred to a traditional classroom by the students. Results also confirmed a significant effect of Constructivist approach on student's achievement and attitude. This study is similar to the findings of an earlier study conducted by Nagalakshmi (2011). Khalid and Azeem (2012) estimated that significant performance of experiment group may be due to teaching student teachers of experimental group with Constructivist Approach. Udogu and Njelita (2010) reported that the constructivist based method is very effective in enhancing meaningful learning among students. Cakici & Yavuz (2010) revealed that there was a significant increase in achievement of fourth grade students within the Experimental Group students compared to the Control Group. In particular, the teaching based on the Constructivist Approach appears to be effective in eliminating the misconceptions the Experimental Group students had prior to the instruction. Wu & Tsai (2010) observed that students in the constructivist-oriented instruction group, in general, attained better learning outcomes about biological reproduction after instruction, both in terms of the extent of concepts and in the richness within their cognitive structures. Akinbobolaa & Afolabib (2010) found that Constructivist practices through guided discovery approaches were the most effective in facilitating students' achievement in physics after being taught using a pictorial organizer. Chang et al (2009) admit that teaching strategy based on the Constructivism and Scaffolding can improve learner's learning effects. Researches also revealed that constructivist approach had positive effect on students' retention. Karaduman and Gultekin (2007) admit that learning materials based on Constructivist approach principles had positive effect on students' retention in Social studies. Similarly when the effect of constructive learning methods was studied on students' retention towards science course, it was revealed that students in experimental group were scored high in the achievement test for retention (Bogal et, al.2012). Kim (2005), state that constructivist teaching is more effective

than traditional teaching in terms of academic achievement of sixth grade students in mathematics; constructivist teaching is not effective in relation to self-concept and learning strategy, but had some effect upon motivation, anxiety towards learning and self-monitoring; a constructivist environment was preferred to a traditional classroom.

Researches also revealed another way to increase the achievement i.e. by exposing the students with daily home work. Harris Cooper a leading expert on the relationship between homework and achievement, defines homework as "tasks assigned by school teachers that are meant to be carried out during noninstructional time" (Bembenutty, 2011). Researches indicated that, along with classroom instruction and students responses to class lessons, home work is an important factor that increases student achievement (Cooper, Robinson & Patall; Keith & Cool 1992; Keith et al 1993; Pascal, Weinstein & Walberg, 1984). Ganiyu (2012) recommended that teachers should endeavour to give home assignments to their students after classroom work daily. This was echoed by Olufemi (2014) who studied the effect of Homework assignment on mathematics achievement of secondary school students and found significant difference between the achievement of students expose to homework assignment daily and those not exposed to homework assignment. Walberg, Pascal and Weinstein (1985;2001) found that daily home assignments resulted in larger effects on students achievement than homework assigned less often or assigned randomly. The highest effect sizes resulted when daily homework assignments were given.

The above analysis of previous researches and their findings raised some research questions such as:

1. Can the weaknesses of traditional method of imparting instructions in science be overcome by the Constructivist Approach based Instructional material?

2. What will be the reaction of students towards science learning through Constructivist Approach based Instructional Material?

3. Does Constructivist Approach based Instructional Material have any effect on achievement of secondary level students?

4. Is there any effect of Constructivist Approach based Instructional Material on retention of secondary level students?

5. Does Daily Home Assignments (DHA's) improve achievement and retention of secondary level students?

As discussed earlier, in the plethora of studies related to constructivism surveyed by the researcher so far it was found that no study has been conducted to study the "Effectiveness of Constructivist Approach based Instructional Material on Reaction, Achievement and Retention of secondary level students". There is a dearth of researches related to the development of instructional material based on Constructivist Approach for the improvement of science teaching. Hence the researcher decided to carry out this research work which is a practical necessity for improvement in the quality of science education as it is a great issue of concern among educationist, policymakers and researchers. The present research work will also be conceived as a means to provide empirical evidence for the above claims in the previous researches.

3.0.0 STATEMENT OF THE PROBLEM

Effectiveness of Constructivist Approach based Instructional material on Reaction, Achievement and Retention of Secondary level students.

4.0.0 DEFINITIONS OF THE TERMS USED IN THE STUDY

4.1.0 Instructional Material

Agina-Obu, 2005 defined Instructional materials as concrete or physical objects which provide sound, visual or both to the sense organs during teaching.

Instructional material in the present study, will consists of the lesson plans based on Constructivist Approach for teaching science subject at senior secondary level.

4.2.0 Constructivist Approach

North Central Regional Educational Laboratory (NCREL) describes Constructivism as an approach to teaching and learning based on the premise that cognition (learning) is the result of "mental construction." In other words, students learn by fitting new information together with what they already know.

Constructivist Approach in teaching of science stipulates that teachers should apply certain strategies and methods which involve students in constructing the desired meaning of scientific concepts and which help the students undergo the desired conceptual change. (Nussbaum and Novick,1982)

4.3.0 Reaction

Oxford Dictionary defines Reaction as, something done, felt or thought in response to a situation or an event.

In this study "Reaction" refers to responses of students towards implementation of Constructivist Approach based Instructional Material in Science teaching.

4.4.0 Achievement

Smith (1969); Spence and Helmereich (1993) described that Achievement is the task oriented behaviour that allows the individuals performance to be evaluated according to some internally or externally imposed criterion, that involves the individual in competing with others, or that otherwise involves some standards of excellence.

In this study Achievement involves performance of students in science subject as indicated by their test scores.

4.5.0 Retention

Your dictionary defines Retention as "The ability to recall or recognize what has been learned or experienced.

In this study retention refers to ability of students to recall what has been learned after implementation of Constructivist Approach and Traditional approach based instructional material in Science, after a certain interval of time.

5.0.0 OBJECTIVES OF THE STUDY

The objectives of the present study are as follows:

1. To conduct content analysis of class IX science text book in light of Constructivist Approach.
2. To develop Constructivist Approach based instructional material for teaching of science in IX class.
3. To compare the effectiveness of Constructivist Approach based instructional material with traditional approach in science.
4. To study the effect of developed Constructivist Approach based Instructional Material in Science on reaction of secondary level students.
5. To study the effect of developed Constructivist Approach based Instructional Material on Science achievement of secondary level students.
6. To study the effect of developed Constructivist Approach based Instructional Material in science on retention of secondary level students.
7. To study the effect of DHAs on Achievement of secondary level students.
8. To study the effect of DHAs on retention of secondary level students.
9. To compare the effect of DHAs and Constructivist Approach based Instructional Material on retention of secondary level students.

6.0.0 HYPOTHESES OF THE STUDY

The null Hypotheses of the present research work are as follows:

H_0 1: There will be no significant difference in mean gain reaction scores of the students taught through Constructivist Approach and traditional approach.

H_0 2: There will be no significant difference in mean gain achievement scores of the students taught through Constructivist Approach and traditional approach.

H_0 3: There will be no significant difference in mean gain retention scores of the students taught through Constructivist Approach and traditional approach.

H_0 4: There will be no significant difference in mean gain achievement scores of the students taught through Traditional Approach with Daily Home Assignment and Traditional Approach without Daily Home assignment.

H_0 5: There will be no significant difference in mean gain retention scores of the students taught through Traditional Approach with Daily Home Assignment and Traditional Approach without Daily Home assignment.

H_0 6: There will be no significant difference in mean gain retention scores of the students taught through Traditional Approach with Daily Home Assignment and Constructivist approach.

7.0.0 VARIABLES OF THE STUDY

In the Experimental phase of the study the following variables will be taken into consideration.

Independent Variables:

Developed Instructional material

Dependent Variables:

Reaction, Achievement and Retention

Extraneous variables:

These variables will be controlled as shown in the following table:

Category of Variables	**Variables**	**Controlling techniques used**	**Methods of controlling**
Subject related variables	Age SES	Sample selection	Through Randomization
	Anxiety Motivation	Rapport establishment	By Researcher
Environment related variables	Classroom climate	Rapport establishment	By Researcher
	Noise	Removed	Psychologically by researcher
	Light Test time Test administration	Constancy	By Researcher
Sequence related variables	Practice	Eliminated	Psychologically by researcher
	Fatigue	Eliminated	Psychologically by researcher
	Cooperation	Constancy	By Researcher

Table 1.1: Methods of controlling Extraneous variables

8.0.0 DELIMITATIONS OF THE STUDY

The study will be delimited in the following ways:

1) The study will be delimited to Agra city only.
2) The study will be delimited to school under Uttar Pradesh Madhyamik Siksha Parishad.
3) The study will be delimited to class IX only.
4) The study will be confined to only Science subject.

9.0.0 METHOD OF THE STUDY

For the achievement of above mentioned objectives Experimental research method will be employed in the present research.

"Experimental method is the description and analysis of what will be or what will occur under controlled conditions". (Best, 1997)

10.0.0 SAMPLE OF THE STUDY

For this study IX class students of science group will be treated as sample and number of sample units for school students is 90. It will be divided into three equal groups, one group will be considered as Experimental group A and second and third group will be considered as Experimental Group B and control group C. Selection of school will be decided according to the situations at the time of research.

The process of sample selection in the present research will be as follows:

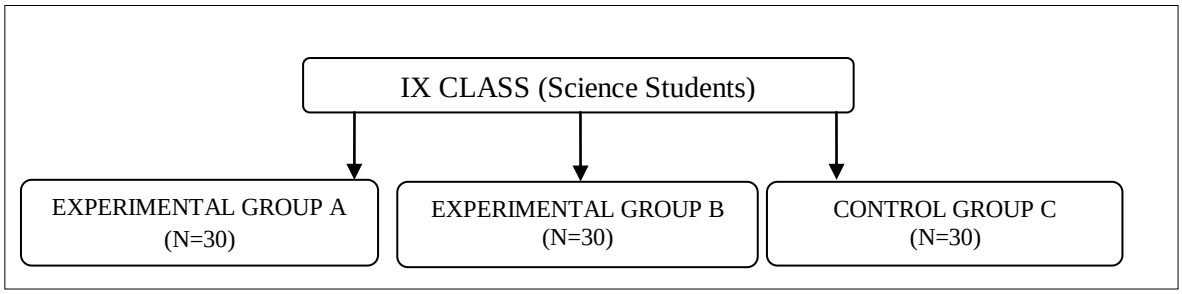


Fig 1.2: Sample of the study

11.0.0 PROCEDURE AND DESIGN OF THE STUDY

Present research work will be based on following procedure and design which are as follows:

11.1.0 Procedure of the study

Procedure of the present study will incorporate following steps:

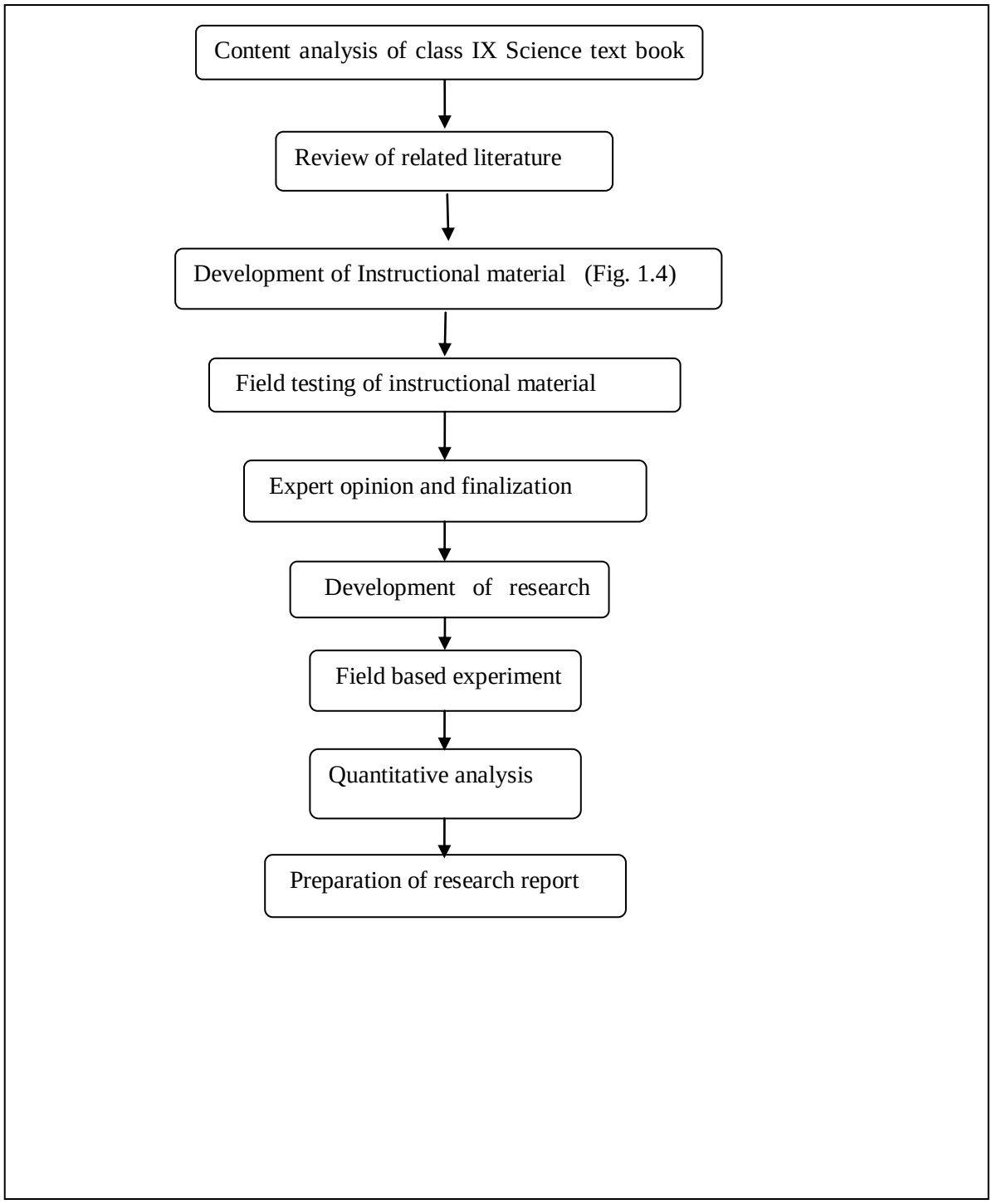

Content analysis of class IX Science text book
Review of related literature
Development of Instructional material (Fig. 1.4)
Field testing of instructional material
Expert opinion and finalization
Development of research
Field based experiment
Quantitative analysis
Preparation of research report

Fig 1.3: Procedure of the study

11.2.0 Steps for developing Instructional material

The researcher will develop an Instructional material based on Constructivist Approach which will be based on following steps:

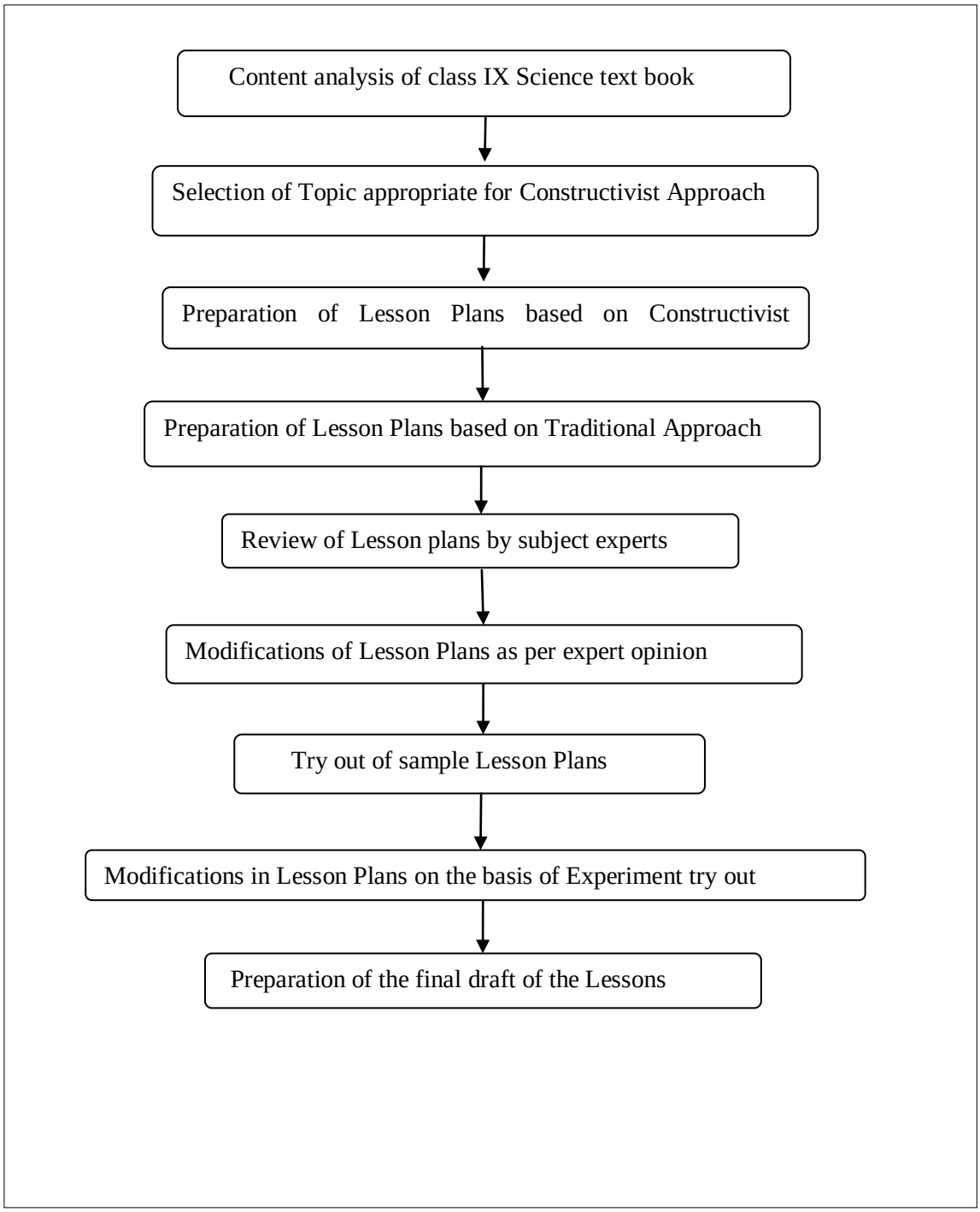

Content analysis of class IX Science text book
Selection of Topic appropriate for Constructivist Approach
Preparation of Lesson Plans based on Constructivist
Preparation of Lesson Plans based on Traditional Approach
Review of Lesson plans by subject experts
Modifications of Lesson Plans as per expert opinion
Try out of sample Lesson Plans
Modifications in Lesson Plans on the basis of Experiment try out
Preparation of the final draft of the Lessons

Fig 1.4: Development of Instructional material

11.3.0 Research Design of the study

Randomized Solomon three group design will be used in the present study:

<table>
<tr><td colspan="12">PHASE I - Development of Instructional Material (Fig 1.4)</td></tr>
<tr><td colspan="12">PHASE II- Implementation of developed instructional material in orientation of science students</td></tr>
<tr><td colspan="4">EXPERIMENTAL GROUP A</td><td colspan="4">EXPERIMENTAL GROUP B</td><td colspan="4">CONTROL GROUP C</td></tr>
<tr><td>Sample</td><td>Treatment</td><td>Duration</td><td>Research tool</td><td>Sample</td><td>Treatment</td><td>Duration</td><td>Research tool</td><td>Sample</td><td>Treatment</td><td>Duration</td><td>Research Tool</td></tr>
<tr><td>School students (N=30)</td><td>Orientation of Constructivist approach through developed instructional material</td><td>15 periods (One period per day)</td><td>Constructivist Reaction scale (CRS)</td><td>School Students (N=30)</td><td>Orientation of Constructivist Approach</td><td>15 periods (one period per day)</td><td>Constructivist Reaction scale (CRS)</td><td>School Students (N=30)</td><td>Orientation of Constructivist Approach</td><td>15 periods (one period per day)</td><td>Constructivist Reaction scale (CRS)</td></tr>
<tr><td colspan="12">PHASE III- Assessment of Effectiveness of developed Instructional material</td></tr>
<tr><td colspan="4">EXPERIMENTAL GROUP A</td><td colspan="4">EXPERIMENTAL GROUP B</td><td colspan="4">CONTROL GROUP C</td></tr>
<tr><td>Sample</td><td>Treatment</td><td>Duration</td><td>Research tool</td><td>Sample</td><td>Treatment</td><td>Duration</td><td>Research tool</td><td>Sample</td><td>Treatment</td><td>Duration</td><td>Research tool</td></tr>
<tr><td>School students (N=30)</td><td>Implementation of developed Instructional material based on Constructivist Approach</td><td>40 periods (One period per day)</td><td>1.Pre-Achievement test
2.Post-Achievement test
3.Constructivist Science Retention Scale (CSRS)</td><td>School students (N=30)</td><td>Teaching science lessons using Traditional Approach with Daily Home Assignments</td><td>40 periods (One period per day)</td><td>1.Pre-Achievement test
2.Post-achievement test
3.Constructivist Science Retention Scale (CSRS)</td><td>School students (N=30)</td><td>Teaching science lessons using Traditional Approach</td><td>40 periods (One period per day)</td><td>1.Pre-Achievement test
2.Post-achievement test
3.Constructivist Science Retention Scale (CSRS)</td></tr>
</table>

12.0.0 TOOLS OF THE STUDY

Following self made tools will be used in the present study:

1. Constructivist Reaction Scale (CRS) to measure the reaction of secondary level students.
2. Science Achievement Test (SAT) to measure achievement of secondary level students.
3. Constructivist Science Retention Scale (CSRS) to measure retention of secondary level students.

13.0.0 STATISTICAL TECHNIQUES

The data will be analysed in light of objectives of the study both qualitatively as well as quantitatively. Certain Descriptive and Inferential statistics will be used in order to describe the nature and distribution of the scores obtained on various tests. This will include following methods of analysis:

1. **Mean:** Mean value will be calculated for the distribution of Reaction scores, achievement scores and retention scores.
2. **Standard Deviation:** It will be calculated to study the variation in the scores.
3. **t-test**: Inferential Statistical techniques such as t-test will be employed for testing significance of the difference between the experimental and control group on the basis of pre-test, post-test scores.

14.0.0 SIGNIFICANCE OF THE STUDY

In the ever-changing world, students having science knowledge can sustain long-run growth of the country. Whether it is a field of health, education or agriculture, students from science discipline are in great demand. There is a need to upgrade teachers' capabilities in most countries, especially with regard to content and pedagogy, and in facilitating hands-on activities for science lessons, as well as on the introduction of contemporary technologies to enhance students' interest, achievement and retention in science subject. The present research work is an

endeavour in this direction i.e. Effectiveness of Constructivist Approach based Instructional Material on Reaction, Achievement and Retention of Secondary level students and will have significance for the following dimensions and personnel:

14.1.0 For Teachers

1) Performance of a teacher is a most crucial input in education field. Present work will help teachers to plan, develop and implement different student centered activities in order to promote interest in students towards science subject.
2) This will encourage teachers to adapt new or innovative approaches of teaching science and they can help their students to be adventurous in their thinking.
3) Teachers can also get insight to adapt innovative approaches of teaching for subjects other than science.

14.2.0 For students

1) Constructivist principles based teaching will develop independent thinking & creativity among students. It will facilitate higher order thinking among them.
2) It will help students in developing their creativity and problem solving skills.
3) Through the processes of constructivism the learners will integrate their new knowledge with the previous one, which in turn will assist them in building their current conceptions.
4) Constructivism is centered on the belief that cognition is the result of "mental construction". Hence, it provides academic freedom to students. Students use their own learning strategies by adapting different approaches of constructivism.
5) Instructional material based on Constructivist Approach will also help students in developing deeper understanding as well as interest in science subject.

14.3.0 For teacher training programme

Both pre-service and in-service training programme, teachers can be empowered to plan and implement Constructivist Approach in particular subject in classroom situation.

14.4.0 For text book writers

It will help textbook writers to write book in sequential order by keeping in mind the Constructivist Approach.

REFERENCES

Acar, B., & Tarhan , L. (2007). Effect of cooperative learning strategies understanding of conce pts in electrochemistry. *International Journal of Science and Mathematics Education, 5,* 349- 373.

Acar, B., &Tarhan , L. (2008). Effect of cooperative learning on students understanding of meta -llic bonding. *Research in Science Education, 38,* 401-420.

Agina-Obu, T. N. (2005). The relevance of instructional materials in teaching and learning. In Robert-Okah. I & Uzoeshi, K. C. (Eds). *Theories and practice of teaching*. Port Harcourt: Harey Publication.

Ajewole, G.A. (2006). Promoting the Understanding of Science, Technology Mathematics (STM) Education in Nigeria for the Future. *Akoko Journal of Pure and Applied Science Education*.

Akinbobolaa, A. O. & Afolabib, F. (2010). Constructivist Practices through guided discovery approach: The effect on students' cognitive achievement in Nigerian Senior Secondary school physics. *2*(1), 16-25.

All India Survey on Higher education (2011-12). Ministry of Human Resource Development, Department of Higher Education, New Delhi. Retrieved from www.aishe.gov.in on 5.9.2015.

Bagchi, J.P. (1997). Let students learn before they learn: A pragmatic approach to science teaching. *Indian Educational Review*. In *Sixth Survey of Educational Research (2002)*, *1*, NCERT, New Delhi.

Bembenutty, H. (2011b). The last word: An interview with Harris Cooper—Research, policies, tips, and current perspectives on homework. *Journal of Advanced Academics, 22*(2), 340–349.

Best, W. J. (1977). Reseach in Education.(3rd ed.). Engle Wood Cliffs, NJ.: Prentice-Hall.

Bogar, Y., Kalender, S.& Sarikaya, S. (2012). The effects of constructive learning methods on students' academic achievement, retention of knowledge, gender and attitudes towards

science course in matter of structure and characterstics unit. Procedia- Social and Behavioral Sciences 46, 1766-1770.

Brookfield, S.D., & Preskill, S. (1999). Discussion as a way of teaching: Tools and techniques for democratic classrooms. *San Francisco: Jossy-Bass.*

Butler, M. B. (1999). Factors associated with students' intention to engage in science learning activities. *Journal of Research in Science Teaching, 36*(4), 455-473.

Cakici, Y. & Yavuz, G. (2010). The effect of constructivist science teaching on 4th grade students' understanding of matter. *Asia Pacific Forum on Science Learning and Tecahing, 11*(2) . Retrieved form http://www.ied.edu.hk on.8.7.2015.

Chang, J. Y.T., Wang, Eric, T.C., Chao, R-M. (2009). Using Constructivism and Scaffolding Theories to Explore Leraning Style and Effect in Blog System Environment. *MIS Review, 15*(1), 29-61.

Chogani, Z. A. (2015). Effect of Educational Planning on School Performance of Students in Experimental Science Book of Third Grade (Primary Schools) Based on constructivism and traditional view. *Journal of Renewable Natural Resources, 3*(1), 369-373.

Claxton, G. (1991). Educating the inquiring mind: The challenge for school science. London Harvester: Wheatsheaf.

Cole, P. (1992). Constructivism revisited: A search for common ground. *Educational Technology, 33*(2), 27-34.

Cooper, H., Robinson, J. C., & Patall, E. A. (2006). Does homework improve academic achievement? A synthesis of research, 1987–2003. *Review of Educational Research, 76*(1), 1–62.

Copeland, I. (2002). Pragmatism: Past examples concerning pupils with learning difficulties. *History of Education, 30* (1), 1-12.

Definition of Retention. Retrieved from http://www.yourdictionary.com/retention.on 20.8.2015

Driver, R., Asoko, H., Leach, J., Mortimer, E. & Scott, P. (1994). 'Constructing Scientific Knowledge in the Classroom. *Educational Researcher, 23*(7), 5-12.

Duckworth, E. (1987). *The having of wonderful ideas" and other essays on teaching and learning*. New York: Teachers College Press.

Duyileni & Bolajoko (2014). Effect of Constructivist Learning Strategies on Senior Secondary School Students Achievement and Retention in Biology. *Mediterranian Journal of Social sciences, 5*(2), 627-633.

Eagly, A.H., & Chaiken, S. (1993). *The Psychology of attitudes*. Fort Worth, TX: Harcourt Brace Jovanovich.

Eagly, A.H., & Chaiken, S. (1995). Attitude strength, attitude structure, resistance to change. In R.E. Petty & J.A. Krosnick (Eds.), Attitude Strength: Antecedences and consequences. Mahwati, NJ: Erlbaum.

Ganiyu, A. A. (2012). The effect of take home assignments on students' performance in mathematics in Nigerian Secondary schools. Journal of Science and Science Education, 3, 83-88.

Gillies, R.M., & Khan, A. (2008). The effects of teacher discourse on student's discourse, Problem solving and reasoning during cooperative learning. *International Journal of Educational Research, 47* (6), 323-340.

Hendry, G. D. (1996). Constructivism and educational practice. *Australian Journal of Education, 40* (1), 19-45.

Hodson, D. (1998). *Teaching and learning science: Towards a personalized approach*. Buckingham: Open University Press.

Hofstein, A., Navon, O., & Kipnis, M. (2005). Developing student's ability to ask more and better questions resulting from inquiry type chemistry laboratories. *Journal of Research in Science Teaching, 42* (7), 791-806.

Howe, A., & Jones, L. (1998). *Engaging children in science.* New York: Merrill.

ICSU (International Council for Science) (2002). Science Education and Capacity Building for Sustainable Development. Series on Science for Sustainable Development No. 5. ICSU, Paris.

ICSU (International Council for Science) (2006).Strategic Plan 2006-2011. Strengthening international science for the benefit of society. ICSU, Paris.

Ilyas, B.M., Wasim, Q., Rawat, K. J. (2014). Effect of Teaching of Fractions Through Constructivist Approach on Learning Outcomes of Public Sector Primary School Teacher. *Bulletin of Education and Research, 36* (1), 15-35.

Jonassen, D.H. (1990). Thinking technology: Toward a constructivist view of instructional design. *Educational Technology, 30* (9), 32-34.

Karaduman, H. & Gultekin, M. (2007). The effect of construtivist learning principles based learning materials to students' attitudes success and retention in social studies.

Kelly (2008). The role of constructivism in teaching and learning chemistry, *Metaphors and Dialetical Thinking (Journal One).*

Khalid, A. & Azeem, M. (2012). Constructivist Vs Traditional: Effective Instructional approach in Teacher education. *International Journal of Humanities and Social Sciences, 2* (15), 170-177.

Kim, J.S. (2005). The Effect of a Constructivist Teaching Approach on Students' Academic Achievement, Self Concept, Learning Strategies. *Asia Pacific Education Review, 6*(1), 7-19.

Koballa, T. R. JR. (1995). Children's attitude toward learning science. In S. M. Glynn, & R. Duit (Eds.), Learning science in the schools: Research reforming practice, Mahwah. NJ: Lawrence Erlbaum Associates, 59-84.

Kruckeberg, R. (2006). A Deweyan perspective on science education: Constructivism, experience, and why we learn science. *Science & Education, 15*, 1-30.

Kwan, Y. W. & Wong, A. F. L. (2015). Effects of constructivist learning environment on students' critical thinking ability. Cognitive and motivational variables as mediators. *International Journal of Educational Research.* Retrieved from www. research gate.net. 20.8.2015 learning. Educational Leadership, 42, 76-79.

Lord, T. R. (1999). A Comparison Between Traditional and Constructivist Teaching in Environmental Science. *Journal of Environmental Education. 30* (3), 22-28.

Lord, T.R. (1997). A comparison between traditional and constructivist teaching in college biology. *Innovative Higher Education, 21* (3), 197-216.

Mayer, R. E. (1992). Cognition and instruction: Their historic meeting within educational psychology. *Journal of Educational Psychology, 84*, 405-412.

Merill, M.D. (1991). Constructivism and Instructional Design. *Educational Technology, 31* (5), 45-53.

Mortimer, E.F. & Scott, P.H. (2000). 'Analysing Discourse in the Science Classroom', in R. Millar, J. Osborne (eds.), Improving Science Education: The Contribution of Research, Open University Press, Buckingham, 126–142.

Nagalakshmi, R. (2011). Effectiveness of Constructivist approach on students' achievement in science, science related attitude, science process skills and perception of nature of science at secondary level. Retrieved from: http://shodhganga.inflibnet.ac.in/simple-search on 5.3.2016.

National Curriculum Framework (2005). National Coucil of Eduactional Research and Training. Delhi.

National Research Council (1996). *National science education standards*. Washington, DC: National Academy Press.

Nuusbaum, J., & Nivick, S. (1982). Alternative frameworks, conceptual conflict and accommodation: Toward a principled teaching strategy. *Instructional Science,11*, 183-200.

OECD (Organisation for Economic Co-operation and Development) (2008). Encouraging Student Interest in Science and Technology Studies, OECD Global Science Forum, p.29.

Olufemi (2014). The Effect of Homework Assignment on Mathematics Achievement of Secondary School Students in South West Nigeria. Journal of Education and Practice, 5,52-55.

Paschal, R.A., Weinstein, T., & Walberg, H.J. (200 1). The effects of homework on learning: A quantitative synthesis . Journal of Educational Research, 78, 97 -104.

Perkins, D. (1993). Teaching for Understanding, American Educator: The professional. *Journal of the American Federation of Teachers; 17*(3) 28-35.

Perkins, D.N. (1991). Technology meets constructivism: Do they make a marriage? *Educational Technology, 31* (5), 19-23.

Ramon, O.G., Akinpelu, Oluyemi, S. (2013). Impact of Constructivist Model Based Training Programme on Pre-Service Teachers' Knowledge, Creativity, Classroom Practice, and Junior Secondary Schools Learning Outcomes in Mathematics. *Journal of Education and Practice, 4* (23), 48-56.

Saye, J.W., & Brush, T. (2006). Comparing teacher's strategies for supporting student inquiry in a problem based multimedia-enhanced history unit. *Theory and Research in Social Education, 34* (2), 183-212. [ERIC Document Reproduction Service No. EJ 760274].

Schreiner, C. & Sjøberg S. (2005). Empowered for action. How do young people relate to environmental challenges? In Alsop, Steve. (2005) Beyond Cartesian Dualism. Encountering Affect in the Teaching and Learning of Science. Springer, Dordrecht. Retrieved from http://folk.uio.no/sveinsj/Springer-ROSE-Schreiner-Sjoberg.pdf on 25.7.2015.

Schreiner, C. & Sjøberg, S. (2007). Science education and youth's identity construction – two incompatible projects? Retrieved from http://www.uv.uio.no on 25.7.2015.

Shepardson, D.P., & Pizzini, E.L. (1993). A comparison of student perceptions of science activities with in three instructional approaches. *School Science and Mathematics, 93*(3), 127-131.

Shukla, R. *et al.* (2005). India Science Report, National Council of Applied Economic Research, New Delhi. Retrieved from http:// www.insaindia.org/India%20Science%20report-Main.pdf on 15.7.2015.

Smith, C.P., (1969). *Achievement related motives in children*, New York: Rusell Sage.

Smorgansbord, A. (1997). Constructivism and Instructional design. Retrieved from http://hagar.up.ac.2a/catts/learner/smorgan/cons.html on 8.7.2015.

Solomon, J. (1987). Social influences on the construction of pupils' understanding of science. *Studies in Science Education, 14,* 63-82

Solomon, J. (1994). The rise and fall of constructivism. *Studies in Science Education, 23,* 1-19.

Spence, J.T., Helmarich, R.L. (1983). *Achievement related motives and behaviours*. In J.T. Spence (Ed.) Achievement and achievement motives. San Francisco: W.H. Freeman.

Sridevi, K.V. (2013). Effect of constructivist approach on Students perception of nature of science at secondary level. Artha *J Soc Sci*, **12**, 1, 49-66.

Stofflett, Rene T. (1998). Putting Constructivist Teaching into Practice in Undergraduate Introductory Science. *Electronic Journal of Science Education*, *3*(2). Retrieved from htt p://unr.edu/homepage/jcannon/ejse/stofflett.html on 17.7.2015.

Taber, K.S. (2006). Beyond Constructivism: the Progressive Research Programme into Learning Science Studies in Science Education, *42*, 125-184.

Udogu, M. E. & Njelita, C. B. (2010). Effect of Constructivist based Instructional Model on Students' Conceptual change and Retention and some difficult concepts in Chemistry. *African Research Review, 4* (2), 219-229.

Vasan, S. & Gafoor, A. P. K. (2014). Effect of Constructivist Classroom Environment on Achievement of Students in Mathematics at Primary school Level. *Journal of Education and Human Development, 3*(2) 619-626.

Virginia Association of Science Teachers (VAST), 1998. What is constructivism and what does it mean for science educators?Current Topics in Science Education. Retrieved from http:// www.pen.k12.va.us/Anthology/Pav/Va_Assoc_Sci/construct2.html on 4.8.2015.

Von Glasersfeld, E. (1989). Cognition, construction of knowledge, and teaching. *Synthese, 80*, 121-140.

Von Glasersfeld, E. (1993). *Questions and answers about radical constructivism.* In Tobin, K. (Ed.), The practice of constructivism in science education, Hillsdale: Lawrence Erlbaum, 23-38.

Walberg, H. J., Paschal, R.A., & Weinstein, T. (1 985). Homework' s powerful effects on

Welligton, J. (2001). What is science education for? *Canadian Journal of Science, Mathematics and Technology Education, 1* (1), 23-38.

Wu, Y. T., Tsai, C.C. (2010). Effects of constructivist oriented instruction on elementary school students' cognitive structures. *Journal of Biological Education, 39*(3), 113-119.

Yager, R. E., & Penick, J. E. (1986). Perception of four age groups toward science classes, teachers and the value of science. *Science Education, 70*(4), 355-363.

Yager, Robert E. 1991. The Constructivist Learning Model. *The Science Teacher. 58*, (6), 53-57.

Yoon, C. (2009). Self regulated learning and instructional factors in the scientific inquiry of scientifically gifted Korean middle school students. *Gifted Children Quarterly, 53* (3), 203-216.

Yore, Larry D. (2001).What is Meant by Constructivist Science Teaching and Will the Science Education Community Stay the Course for Meaningful Reform? *Electronic Journal of Science Education, 5* (4). Retrieved from http://unr.edu/homepage/crowther/ejse/yore.html.2.8.2015

Zoller, Uri. (2000). Teaching Tomorrow's College Science Courses-Are We Getting It Right? *Journal of College Science Teaching, 29*(6), 409-414.